APPLIED MATHEMATICS (PHD)

Graduate School

Program Website (https://www.cam.cornell.edu/cam/academics/phd-program/)

CIP: 27.0301 | **HEGIS:** 1703.00 | **NYSED:** 13443

Graduate Field

Applied Mathematics (https://catalog.cornell.edu/graduate-school/applied-mathematics/)

Program Description

The graduate program in applied mathematics is based on a solid foundation in pure mathematics, which includes the fundamentals of algebra and analysis. It involves a grounding in the methods of applied mathematics and studies of scientific areas in which significant applications of mathematics are made. The field has a broadly based interdepartmental faculty that can direct student programs in a large number of areas of the mathematical sciences.

Many specialized or interdisciplinary programs can be designed for individual students, including, for example, a variety of possibilities in biomathematics.

The dissertation is normally a mathematical contribution toward the solution of a problem arising outside mathematics.

Concentrations

- Applied mathematics

Program Information

- Instruction Mode: In Person
- Location: Ithaca, NY
- Minimum Credits for Degree: 144

Program Requirements

- Minimum Semesters for Degree: 8

Graduate School Milestones

- Responsible Conduct of Research Training: Required
- Open Researcher and Contributor ID (ORCID): Required
- Student Progress Reviews (SPR) begin: Second Year
- Examination for admission to candidacy (A Exam): Spring or summer of third year
- The A-Exam must be scheduled before the beginning of the seventh semester unless a special petition is filed. The A-Exam should be scheduled well in advance of the exam and the appropriate form (Schedule of Examination form) must be submitted to the Graduate School at least 7 calendar days ahead. CAM graduate students are eligible for a Non-Thesis Masters Degree upon completion of the A-Exam. In order for this to be awarded, the Committee Chair must check the relevant box on the Results of Examination Form. The form must be turned into the Graduate School within 3 days after the exam.
- Defense of Dissertation (B Exam): Spring or summer of fifth year
- The B-Exam is scheduled with the same form as the A-Exam and must be submitted to the Grad School at least 7 calendar days ahead.

Field Specific Milestones

- End of semester audit for enrolled students

Course Requirements

- Course requirements are determined by the student's Special Committee.
- Enrollment in GRAD research course or the equivalent field specific research course is expected of all students.

The following are required for admission to candidacy for the Ph.D., or to obtain an M.S. degree in Applied Mathematics:

1. Prerequisite to the graduate program are familiarity with analysis and algebra at the advanced undergraduate level (e.g., MATH 4130-MATH 4140 and MATH 4330-MATH 4340). Students lacking either prerequisite (which may be determined by their special committee chair and/or the CAM Director), should take the appropriate courses within their first two years of study. No more than two of these courses can count towards meeting other CAM degree requirements.
2. Students are required to take at least eight courses in mathematics and its applications that are approved by their special committee, at least 4 of which must be numbered 6000 or above. Suggested areas for these courses are given in the list of Focal Areas for Applied Mathematics (https://cam.cornell.edu/academics/phd-program-focal-areas/).
3. The courses taken to satisfy item (2) must include an advanced course in computational methods (focal area (a)). In order to achieve breadth in Applied Mathematics, courses from at least three other Focal Areas should normally be included. Should a course be listed under more than one focal area, then it will count towards only one such area as chosen by the student's Special Committee.
4. Students are required to have minors in Mathematics and in another field relevant to their doctoral research. Note that the course requirements listed above may suffice to satisfy the requirements for a graduate minor in Mathematics.

Exceptions to these requirements can sometimes be made, if approved in advance by the student's Special Committee and the CAM Director. All requirement courses must be taken for a letter grade.

Focal Areas for Applied Mathematics

The seven major Focal Areas for the field of applied mathematics are listed below, along with examples of recommended courses for completing the requirements in each focal area. In addition to the listed example courses, appropriate courses containing substantial mathematical content, offered by any department, may be taken to satisfy field requirements in mathematics and its applications, subject to approval by the student's Special Committee.

All coursework that is part of graduate curriculum must be taken at the 5000 level or higher, other courses will not count toward graduate degrees.

A. Computational Methods

Code	Title	Hours
CEE 5745	Inverse Problems: Theory and Applications	3
CEE 6300	Spectral Methods for Incompressible Fluid Flows	4
CEE 6720		
CS 6210	Matrix Computations	3
CS 6220	Data-Sparse Matrix Computations	3
CS 6241	Numerical Methods for Data Science	3
MAE 6230	Computational Fluid Dynamics	4
MATH 5250	Numerical Analysis and Differential Equations	4
MATH 4260	Numerical Analysis: Linear and Nonlinear Problems [1]	4

[1] MATH 4260/CS 4220 has not yet been designated with a 5000 level course number and may not be offered to graduate students for some time.

B. Mathematical Analysis

Code	Title	Hours
MATH 6110	Real Analysis [1]	4
MATH 6120	Complex Analysis [1]	4
MATH 6210	Measure Theory and Lebesgue Integration	3
MATH 6220	Applied Functional Analysis [2]	3
MATH 7130	Functional Analysis [2]	3

[1] Not both MATH 6110 and MATH 6210.
[2] Not both MATH 6220 and MATH 7130.

C. Differential Equations and Dynamical Systems

Code	Title	Hours
CEE 5735	Mathematical Modeling of Natural and Engineered Systems	3
CHEME 7530		
MAE 5790	Nonlinear Dynamics and Chaos	3
MAE 6010	Foundations of Fluid Mechanics I	4
MAE 6110	Foundations of Solid Mechanics I	3
MAE 6330		
MAE 6840		
MATH 6260	Dynamical Systems	3
MATH 6180		
MATH 6150	Partial Differential Equations	3
MATH 6160	Partial Differential Equations	3
MATH 6230	Differential Games and Optimal Control	4
MATH 6280		
MATH 6520	Differentiable Manifolds (crosslisted)	4

D. Stochastic Methods (Probability, Stochastic Processes, Statistics, Machine Learning, Signal and Image Processing, etc.)

Code	Title	Hours
BTRY 7180	[1]	
CS 6780	Advanced Machine Learning	4
CS 6783	Machine Learning Theory	4
CS 6784	Advanced Topics in Machine Learning	4
CS 6788	Advanced Topic Modeling	3
ECE 5555		
ECE 5620	Fundamentals of Data Compression	3
ECE 5630		
MATH 6710	Probability Theory I	3
MATH 6720	Probability Theory II	3
MATH 6730	Mathematical Statistics I	3
MATH 6740	Mathematical Statistics II	3
MATH 7740	Statistical Learning Theory	3
ORIE 6500	Applied Stochastic Processes	4
ORIE 6510	Probability	4
ORIE 6540		
ORIE 6570		
ORIE 6580	Simulation	3
ORIE 6700	Statistical Principles	4
ORIE 6710		
ORIE 6720		
ORIE 6750		3
ORIE 6780	Bayesian Statistics and Data Analysis	3
STSCI 6520	Statistical Computing I	4
STSCI 7170	Theory of Linear Models	3

[1] Most 6000-level BTRY courses not suitable.

E. Optimization and Discrete Mathematics

Code	Title	Hours
MATH 5410	Introduction to Combinatorics I	4
MATH 4420	Introduction to Combinatorics II [1]	4
MATH 6230	Differential Games and Optimal Control	4
ORIE 6300	Mathematical Programming I	4
ORIE 6310		
ORIE 6320		
ORIE 6325		
ORIE 6327		
ORIE 6328	Convex Analysis	3
ORIE 6330		3
ORIE 6334	Combinatorial Optimization	3
ORIE 6335		

[1] MATH 4420 has not yet been designated with a 5000 level course number and may not be offered to graduate students for some time.

F. Algorithms and Complexity

Code	Title	Hours
CS 4814	Introduction to Computational Complexity [1]	3
CS 6810	Theory of Computing	4
CS 6820	Analysis of Algorithms	4
CS 6840	Algorithmic Game Theory	4
ORIE 6350		

[1] CS 4814 has not yet been designated with a 5000 level course number and may not be offered to graduate students for some time.

G. Algebra and Logic

Code	Title	Hours
CS 6117	Category Theory for Computer Scientists	4
CS 6764	Reasoning about Knowledge	4
CS 6766	Reasoning about Uncertainty	4
CS 6860		
MATH 6310	Algebra	4
MATH 6320	Algebra	4
MATH 6340	Commutative Algebra with Applications in Algebraic Geometry	3
MATH 6390	Lie Groups and Lie Algebras	3
MATH 6810	Logic	3
MATH 7880		

University Graduation Requirements Requirements for All Students

In order to receive a Cornell degree, a student must satisfy academic and non-academic requirements.

Academic Requirements

A student's college determines degree requirements such as residency, number of credits, distribution of credits, and grade averages. It is the student's responsibility to be aware of the specific major, degree, distribution, college, and graduation requirements for completing their chosen program of study. See the individual requirements listed by each college or school or contact the college registrar's office (https://registrar.cornell.edu/service-resources/college-registrar-directory/) for more information.

Non-academic Requirements

Conduct Matters. Students must satisfy any outstanding sanctions, penalties or remedies imposed or agreed to under the Student Code of Conduct (Code) or Policy 6.4. Where a formal complaint under the Code or Policy 6.4 is pending, the University will withhold awarding a degree otherwise earned until the adjudication process set forth in those procedures is complete, including the satisfaction of any sanctions, penalties or remedies imposed.

Financial Obligations. Outstanding financial obligations will not impact the awarding of a degree otherwise earned or a student's ability to access their official transcript. However, the University may withhold issuing a diploma until any outstanding financial obligations owing to the University are satisfied.

Learning Outcomes

A graduate student in Applied Mathematics is expected to demonstrate both mastery of knowledge in mathematics and its applications, and ability to create new mathematical knowledge and innovative ways to apply mathematical tools to important problems in science, industry and society.

Each student is expected to demonstrate the following proficiencies.

- Make substantial original contributions to applied mathematics:
  - Identify new important and promising research problems
  - Think independently, critically and creatively
  - Complete research work by bringing it to the stage where it can be published and be used by the others
- Maintain ability to acquire new knowledge by keeping up with the new developments in the field through professional publications and professional meetings.
- Ability to communicate effectively research findings and plans:
  - Present results in the format of technical papers and have them published in professional journals and conference proceedings
  - Explain complex ideas to peers in technical presentations; being aware of funding opportunities and ability to write effective research proposals and obtain research funding
- Dedication to advancing science through effective teaching, advising, mentoring and service to professional community.
- Awareness of the ethical standards in the field, and ability to maintain and advance these standards.